Nano-Micro Mechanics Assisted Chopped Fiber Composite Material Modeling

Challenge

PBT-SGF30 comprises of short chopped fiberglass fibers reinforcing polybutylene Terephthalate (Thermoplastic). The coupons were made using injection molding process and the stress-strain curve data for flow, cross and 45 deg oriented (from principal direction) direction coupon were obtained. The key challenge of this case study is to calibrate chopped composite material properties that will satisfy the stress strain curves obtained from test.

The objective of this case study is to (**1**) predict nano mechanics (MCQ-Chopped) assisted aligned layer chopped fiber composite properties, reverse engineer orientation of chopped fiber through the thickness and predict flow/cross-flow/45-degress stress strain cures and compare with test; and (**2**) obtain micro mechanics (MCQ-Composite) assisted effective fiber/matrix properties and the corresponding flow/cross-flow/45-degress stress strain curves were predicted and compare with test as well.

Material	Fiber/Polymer	Specimen View	Manufacturing
PBT-SGF30	Fiberglass + PolyButylene Terephthelate (**Thermoplastic**)	 Short Fiber Distribution	Injection Molding

Material Description

Solution

Methodology involved in the case study includes Mori-Tanaka, Equivalent Laminate Analogy, Classical Laminate Theory (Analytical)

The step by step process involved in this case study as well as a work-flow chart which provides the input and output of the proposed steps is shown next.

- **Step-1:** MCQ-Chopped software is used to predict the aligned layer ply properties and predict flow/cross-flow/45-degress stress strain curves.
- **Step-2:** MCQ-Composites software is used to calibrate effective fiber/matrix non-linear properties and predict flow/cross-flow/45-degress stress strain curves.

Step 1
Test Validation using ply properties

Software: MCQ-Chopped
Input: Vendor provided fiber/matrix properties, fiber geometry and content, flow/cross-flow stress strain curves

Output: Aligned layer non linear ply properties, orientation angle through thickness and longitudinal/transverse/shear stress-strain curves for validation

Step 2
Test Validation using effective fiber/matrix properties

Software: MCQ-Composite
Input: Aligned layer ply properties from MCQ-Chopped, fiber/matrix modulus, flow stress strain curves

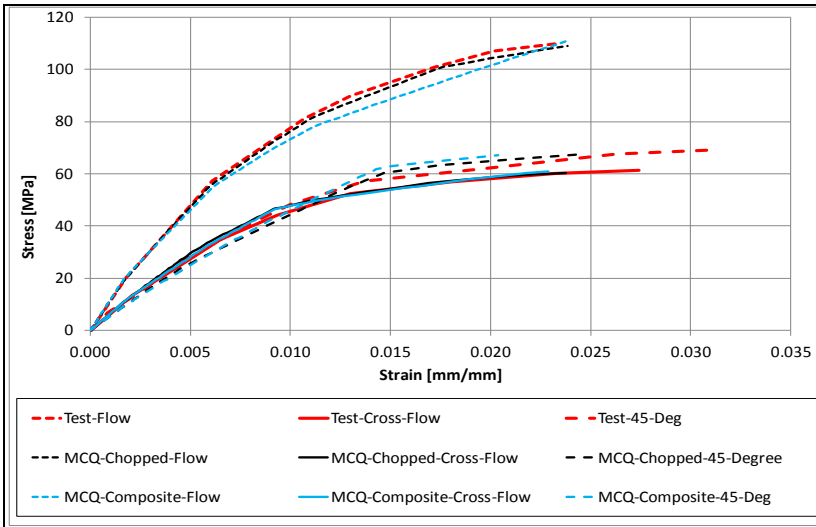
Output: effective fiber/matrix non-linear properties and longitudinal/transverse/shear stress-strain curves for validation

Work-Flow: MCQ-Chopped Integration in MCQ-Composites

Results & Conclusion

- Prediction of the stiffness and strength properties of an injection molded chopped composite build.
- Reverse Engineer fiber orientation through thickness.
- The calibration process generates fiber and matrix in-situ properties, while the prediction process produces the elastic and mechanical properties of the given injection molded composite coupon laminate.

Key Highlights & Benefits
Product: MCQ-Chopped and MCQ-Composites
Industry: Aerospace and Automotive
Application: Injection Molding
Benefits: (**1**) De-Homogenization Approach: models composite constituents and chopped fiber orientation; (**2**) Considers effect of Defects; (**3**) Accurately predicts strength in addition to stiffness



Comparison of test vs. MCQ-Chopped and MCQ-Composite stress-strain curves

Related Publication

Effects of fiber orientation and anisotropy on tensile strength and elastic modulus of short fiber reinforced polymer composites, Composites Part B: Engineering 72 (2015): 116-129.